

DEPARTMENT OF THE INTERIOR WEATHER PROGRAMS

The Interior Department (DOI), is the nation's principal conservation agency, charged with the mission "to protect and provide access to our Nation's natural and cultural heritage and honor our trust responsibilities to Indian tribes and our commitments to island communities." The following operational and research programs contribute to the Federal Plan.



UNITED STATES GEOLOGICAL SURVEY (USGS)

Water Data

The USGS's Water Resources Division (WRD) collects streamflow, precipitation, water quality, ground-water level, and other water resources and climatological data as part of a national network and for a number of projects concerning rainfall/ runoff, water quality and hydrologic processes. Currently, the USGS collects hydrologic and meteorological data from more than 11,000 surface-water sites, precipitation data from more than 1,100 sites, ground-water level data from more than 21,000 sites, and water quality data from more than 8,500 surface-water, ground-water, and precipitation sites.

Data collected at USGS sites are transmitted from approximately 7,100 remote Data Collection Platforms (DCPs). The data are transmitted to Wallops, Virginia, via GOES and rebroadcast to a domestic communication satellite (DOMSAT). Data are received from the DOMSAT by local readout ground stations (LRGS) procured by USGS under a 1992 contract. The USGS currently operates 15 LRGS which provide near-real-time data to the USGS's computerized National Water Information System (NWIS). Data from an additional 1,300 sites are transmitted via other telemetry (mostly telephone). Near-real-time streamflow data and ancillary information are provided to National Weather Service River Forecast Centers for over 2000 river forecast points (Figure 3-DOI-1).

The USGS also collects precipitation samples in a number of studies for the determination of atmospheric contribution to the chemical constituent loads to runoff, and for defining the effect of atmospheric deposition on water quality and the aquatic environment.

The USGS serves historical and real-time water resources data on the Internet at its NWIS Web site (<http://waterdata.usgs.gov/nwis/>).

Snow and Ice Studies

The USGS is carrying out a joint research program with NASA, the University of Washington-Seattle's Electrical and Civil Engineering Departments, and the French Space Agency (CNES) to measure snowpack water equivalent or snow depth using satellite passive microwave observations from the Defense Meteorological

Satellite Program's (DMSP) Special Sensor Microwave/Imager (SSM/I) sensor. Unlike observations in the visible bands, passive microwave observations are independent of cloud cover and solar illumination and respond to both snow depth and snowpack grain size. The satellite observations are being compared to snowpack data, which include grain size, density and stratigraphy, from a variety of sources: USDA/NRCS automatic SNOTEL sites; National Weather Service (NWS) sites; and observations by USGS field teams. The object of the program is to develop algorithms to extract snow depth or water equivalent information from the satellite observations to be used in near-real-time water resource assessments and in climatological studies based on snowpack distributions determined from the two-decade-

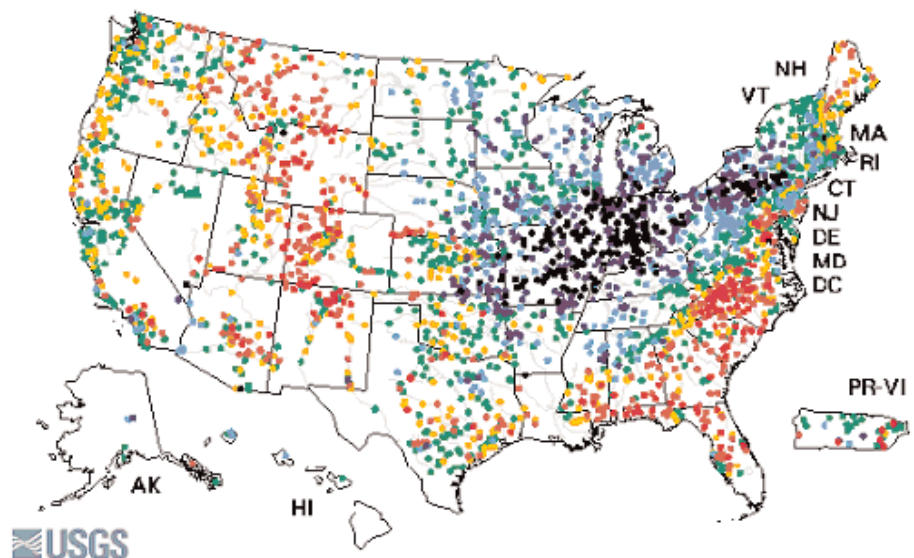


Figure 3-DOI-1. Sample USGS Water Watch map of real-time streamflow compared to historical streamflow for the day of the year. Source: USGS Website: <http://water.usgs.gov/waterwatch/>

long DMSP satellite record. The investigation is developing techniques to utilize algorithms that include the effects of grain size metamorphoses and to incorporate these algorithms into hydrologic models.

The USGS and the BLM have used a combination of Landsat-7 and synthetic aperture radar images of the Bering Glacier, Alaska, which surged in 1993-95, to map the retreat of the glacier terminus as it undergoes large scale disarticulation. Scientists use these data to monitor the level of Berg Lake and the integrity of the ice dam that forms the southern shore of the lake, to assess the potential hazard presented by an outburst flood. In addition, the imagery is being used to plan summer field programs that include hydrographic investigations in expanding Vitus Lake, and both aquatic and terrestrial sampling.

Climatological Research

USGS also carries out research in climate change, regional hydrology, the carbon cycle, coastal erosion, volcanic activity, and glaciology. As part of its glaciology program, the USGS maintains an observation program on three benchmark glaciers representative of different climactic zones of the western United States, one in Washington, one on the south coast of Alaska and one in the interior of Alaska. At each glacier, the program measures the winter snow accumulation, summer snow and ice ablation, air temperature, and runoff in the glacier basin. The length of the glacier record is now 43 years; this is the longest such record in North America. Analysis of this record is providing a greater understanding of the climate variability and its effects on water resources of the western United States. The record clearly shows the effects of changing winter precipitation patterns associated with El Niño and La Niña events. In addition, the record from South Cascade Glacier, in Washington State, indicates that we are returning to the cool phase of the Pacific Decadal Oscillation.

USGS scientists have developed and tested methodology to use Landsat-7 data in conjunction with USGS mass balance measurements at South Cascade Glacier, Washington, to estimate the annual storage or release of water by glaciers and perennial snowfields in the North Cascade Mountains. The method was applied to the North fork of the Nooksack River, Washington, for three consecutive years with different snow accumulations: a heavy snow year, 1999, a normal snow year, 2000, and a light snow year, 2001, a drought year. The results show that in a drought year the glaciers and perennial snow fields, which comprise 4.8 percent of the drainage, contribute 4.5 percent of the total annual flow. This technique can form the basis of extrapolating mass balance measurements to assess the impact of glaciers on regional hydrology.

Geomagnetic Data

The Geomagnetism Program (<http://geomag.usgs.gov>) of the USGS Central Region Geohazards Team provides real-time, ground-based measurements of the Earth's magnetic field, which are an important contribution to the diagnosis of conditions in the near-Earth space environment of the sun, the solar wind, the magnetosphere, the ionosphere, and the thermosphere. During geomagnetic storms, brought about by the complex interaction of the Earth's magnetic field with that of the Sun's, both high- and low-frequency radio communications can be difficult or impossible, global positioning systems (GPS) can be degraded, satellite electronics can be damaged, satellite drag can be increased, and astronauts and high-altitude pilots can be subjected to enhanced levels of radiation.

Ground-based geomagnetic observatory data are complementary to those collected by space-based satellites; indeed, most of the hazardous effects on technological systems brought about by magnetic storms occur at or near the Earth's surface. Therefore, the

Geomagnetism Group monitors the surficial magnetic field by operating 14 magnetic observatories in the United States and its Territories. The data from these observatories, plus 15 foreign observatories, are transmitted to the Group's headquarters in Golden, Colorado, where they are processed and analyzed. Data are then transmitted to the Space Environment Center (SEC) of the National Oceanic and Atmospheric Administration (NOAA) and to the United States Air Force (USAF) Air Force Weather Agency at Offutt AFB, Nebraska.

USGS observatories are operated in cooperation with Intermagnet, an international consortium overseeing the operation of nearly 80 geomagnetic observatories distributed around the globe. The roles and responsibilities of agencies participating in the National Space Environment and Warning Program are detailed in the *National Space Weather Program Strategic Plan* (FCM-P30-1995).

Volcanology and Volcanic Ash Plumes

The USGS participates in the Working Group for Volcanic Ash (WG/VA) of the OFCM. This working group is preparing a *National Framework for Volcanic Ash Hazards to Aviation*. Through its Volcanic Hazards Program, the USGS is responsible for monitoring volcanoes in the United States; of the approximately 70 historically active volcanoes in the United States, more than 40 are in Alaska. Until the 1980's, the Alaskan volcanoes had been largely unstudied. Despite Alaska's low population density over much of the state, Alaska's volcanoes underlie the heavily traveled air routes of the North Pacific region.

During recent years, the USGS's Alaskan Volcano Observatory (AVO) has expanded its network of real-time seismic monitoring stations to bring 25 of the Alaska's volcanoes under continuous, real-time surveillance. Data and information from the AVO monitoring activities are integrated directly into

the regional operational activities of the FAA, DOD, and NOAA/NWS to provide warnings for pilots and aircraft operators in the Alaskan region.

Internationally, the OFCM's WG/VA supported expansion of USGS monitoring activities in the remote Pacific Rim of explosive volcanoes. The 100 historically active volcanoes in Alaska, Kamchatka, and the Kuriles are monitored through satellite imagery several times a day. Currently, about 220 aircraft per day - carrying about 20,000 passengers and millions of dollars of cargo value -- fly international Northern Pacific Routes near these historically active volcanoes. About half these flights are United States carriers. AVO, through its working agreement with the Kamchatkan Volcanic Eruptions Response Team (KVERT) in Petropavlovsk-Kamchatsky, Russia, also supplies information about eruptive activity in Kamchatka and the Kuriles to the FAA, the NWS, and numerous domestic and foreign air carriers.

In 2003, the USGS responded to the eruption of Anatahan Volcano in the Northern Marianas, a Trust Territory of the United States, which affected aviation flying across the Pacific. A small monitoring system was installed and a protocol was established with the FAA, NOAA, and USAF to notify them of any significant changes. Activity at Anatahan continues.

The USGS, OFCM, and other United States and international sponsors organized the *Second International Conference on Volcanic Ash and Aviation Safety* on 21-24 June 2004 in Alexandria, Virginia. The conference was a 4-day assembly of the international aviation, governmental, and scientific community involved with the ash issue. The conference provided a forum for exchanging technical and operational information, with the goal of identifying ways to improve mitigation of the ash hazard to aviation. The

agenda included a combination of plenary sessions, poster presentations, and informal discussions on the topics of eruption monitoring and reporting, ash-cloud detection and forecasting; case histories of encounters and operational solutions, Volcanic Ash Advisory Center operations, the needs of the aviation industry, and education and outreach. More detailed information about the conference is on-line at: http://www.ofcm.gov/homepage/text/spc_proj/volcanic_ash/about.html.

BUREAU OF LAND MANAGEMENT (BLM)

The BLM is one of five Federal Land Management agencies which have centralized Wildland fire weather operations at the National Interagency Fire Center (NIFC), in Boise, Idaho. The BLM's Initial Attack Management System (IAMS) was designed in the mid-1980's to provide real-time data access and modeling for the fire management organization. The IAMS required a considerable dedicated telecommunications network for data distribution. In an effort to reduce these inherent telecommunications costs, the BLM has moved into a "web server" environment. Many of the

capabilities that were centrally located in the old IAMS have been moved to other web sites.

Fire Weather Websites

The principal Wildland Fire Management Information System (WFMIS) inputs remain the same with Remote Automatic Weather Station (RAWS) and National Lightning Detection Network (NLDN) information (Figure 3-DOI-2). BLM's new server system is called the BLM Wildland Fire Management Information Site (www.nifc.blm.gov). Additional fire management information is summarized and made available at the Desert Research Institute (wrcc.dri.edu and cefa.dri.edu) and the United States Forest Service Wildland Fire Assessment System ([//svinet2.fs.fed.us/land/wfas/](http://svinet2.fs.fed.us/land/wfas/)). Additionally, the BLM has utilized the Desert Research Institute's capabilities to respond quickly for website support.

Automated Weather Stations

The BLM's RAWS Program primarily collects meteorological data for fire weather forecasting. However, use of BLM's RAWS data set by other non-fire users has generated sufficient funding to permit year-round operation of the entire network. The BLM's

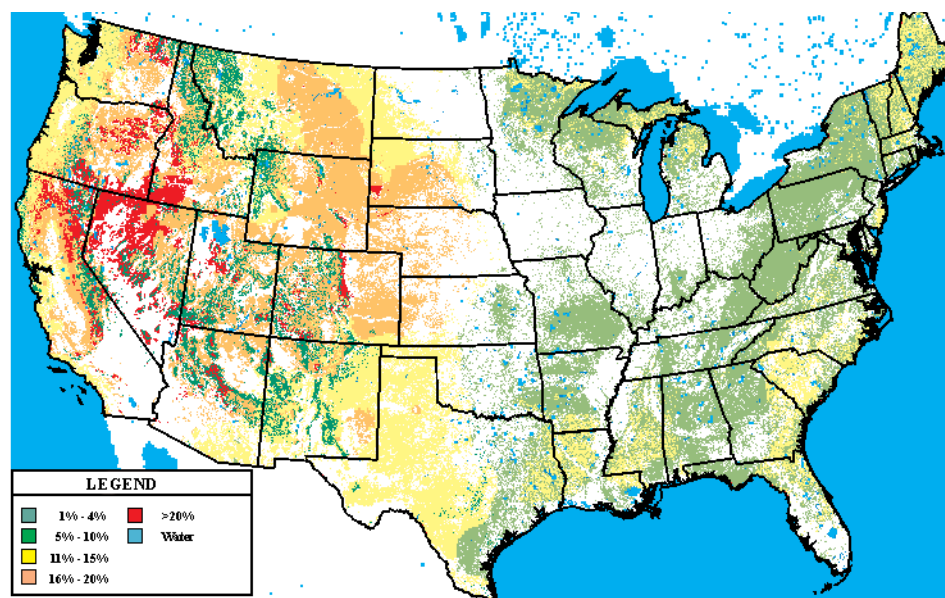


Figure 3-DOI-2. A National Interagency Fire Center graphic of Lightning Ignition Efficiency for the lower 48 states.

Resource Management and Oregon O&C (West-Side) also operate RAWS networks which are much smaller and have specific program requirements that differ from fire management.

Lightning Detection

In 1997, the BLM began contracting with a private vendor via the NWS for lightning location data. Data are received at the NIFC in Boise, Idaho, and placed on the BLM WFMIS for qualified user access. Current plans are to continue the operation of the Alaska Automatic Lightning Detection System as an independent government-owned and operated system.

Fire Weather Support

The BLM's Remote Sensing/Fire Weather Support Unit (RSFWSU) at NIFC provides the full range of program management, equipment dispatch, field and depot maintenance, support and data services for the BLM and numerous other government agencies. This interagency-staffed and funded facility performs work under long term agreements with those agencies within the government having similar equipment and requirements.

Climate Monitoring

In addition to the meteorological monitoring BLM conducts primarily to support wildland fire management activities, the BLM also conducts site-specific climate monitoring at over 200 manual weather station locations on the public lands in the 11 western states and Alaska. The operation of these sites ranges from seasonal to annual, taking measurements of precipitation, temperature, soil moisture, and other meteorological parameters necessary to assess local climatic influences. These data are primarily used for natural resources management and planning at the local level.

Portable Weather Stations

During the 1999 fire season, the Remote Sensing/Fire Weather Support Unit began a 2-year "proof of concept" effort with a portable weather station referred to as the Fire RAWS (FRWS).

FRWS are intended for use on or near a fire line and can be rapidly relocated to points desired by Fire Behavior Analysts for real-time weather data. Due to the extreme fire season in both 1999 and 2000, the FRWS was used extensively and was found to be a valuable asset for firefighter safety and fire weather forecasting. Fire managers have also increased the use of FRWS to monitor intentionally-initiated prescribed burns.

Currently, 33 FRWS systems are cached at NIFC for use during the 2005 season. FRWS collect, store, and forward data by interrogated voice radio with new data available every fifteen minutes. Satellite data can be retrieved from the BLM/NIFC website, and hourly satellite data is available to Fire Weather Forecasting Staff for spot forecasts and fire support from all central locations (Geographic Area Coordination Centers, NIFC, etc.).

All Risks Support

After the terrorist attack on September 11, 2001, the RSFWSU was tasked to provide near real-time meteorological data collection at the

World Trade Center (Figure 3-DOI-3). This effort was in direct support of the Environmental Protection Agency's task of monitoring air quality in the vicinity of the collapsed towers. The unit also provided remote meteorological support for the Columbia Shuttle accident investigation and recovery effort, and RAWS support has generated interest from the Department of Homeland Security as it assesses its needs for remote and urban environmental monitoring. Using the personnel and resources available at the RSFWSU, the BLM can offer a rapid meteorological support capability that is unique across the federal government.

BUREAU OF INDIAN AFFAIRS (BIA)

The Bureau of Indian Affairs collects atmospheric data to evaluate potentially irrigable Indian Trust lands in the Southwest. The Bureau also collects and shares fire weather data with other federal agencies while participating in fire management activities for local and interagency use.



Figure 3-DOI-3. Remote Sensing/Fire Weather Support Unit providing near-real-time meteorological data collection at the World Trade Center.

Currently, BIA operates the following instrumentation:

- 69 fire weather RAWS stations (permanent stations)
- 5 "manual" weather stations
- 13 portable RAWS stations used for Prescribed Fire
- 10 RAWS deployed on emergency stabilization projects.

MINERALS MANAGEMENT SERVICE (MMS)

The Minerals Management Service (MMS) Environmental Studies Program gathers offshore environmental data for use in the management of offshore oil and gas resources. Currently, MMS is funding the continued operation of five offshore meteorological buoys. Two buoys are located in the Gulf of Mexico and three in the Pacific Ocean off California. The MMS also utilizes data from other buoys funded by NOAA. The buoys collect air temperature, sea surface temperature, wind direction, wind speed, wave height, and wave spectrum data. Many of the buoys measure relative humidity as well.

The MMS has completed a study entitled *Boundary Layer Study in the Western and Central Gulf of Mexico*. This report synthesized three years of data collected from two radar profilers and Radar Acoustic Sounding System (RASS) units placed in the Gulf of Mexico along with data from NOAA's National Data Buoy Center buoys, coastal surface stations, NWS rawinsonde sites, and Eta model runs. The study also include one year of data collected in the Breton Aerometric Monitoring Program (BAMP), an industry-sponsored study using a network of profilers and surface stations on platforms around the Breton National Wilderness Area (NWA) off southeastern Louisiana. Copies of interim and final reports may be found at http://www.gomr.mms.gov/homepg/regulate/envirom/techsumm/rec_pubs.html. The meteorological data will be

used in an air quality modeling study to assess air quality impacts from offshore oil and gas development on the Breton NWA.

The Service has entered into a cooperative agreement with the Visibility Improvement State and Tribal Association of the Southeast (VISTAS) to install and operate a radar profiler at the Pensacola Naval Air Station in the Florida Panhandle. VISTAS is a regional planning organization representing a collaborative effort of state governments, tribal governments, and various federal agencies established to initiate and coordinate activities associated with the management of regional haze, visibility and other air quality issues in the Southeastern United States. The profiler is expected to be installed and operational in the summer of 2004. MMS is also installing a profiler at the Louisiana Universities Marine Consortium (LUMCON) facility in Cocodrie, Louisiana. This profiler is expected to be installed in the summer of 2004. The data collected will be applied to regional models for

evaluating impacts from emission sources on ozone, fine particulate matter, and regional haze.

NATIONAL PARK SERVICE (NPS) AND FISH AND WILDLIFE SERVICE (FWS)

The Park Service monitors air quality and visibility in several national parks and monuments. Gaseous pollutants data are collected on continuous and integrated (24-hour) bases. Surface meteorological data are collected and analyzed for hourly averages. Precipitation chemistry is determined on week-long integrated rainfall samples. Twenty-four hour, average particle concentrations (mass, elemental analyses, some chemical constituent analyses) are measured twice weekly. Atmospheric light extinction is measured continuously and relayed to a central location for analyses (Figure 3-DOI-4).

The NPS also conducts and contracts research to develop and test air quality models to assess long-range transport, chemical transformation, and deposi-

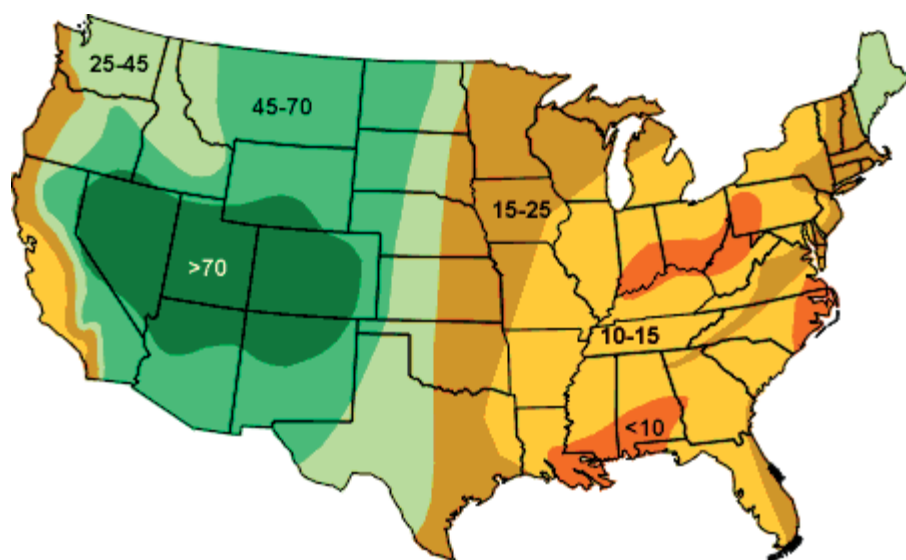


Figure 3-DOI-4. Visibility impairment causes landscape features and colors to fade, diminishing the experience of park visitors. Poorest visibility occurs east of the Mississippi River and in the urban areas of California. NPS monitors visibility conditions and conducts studies to determine the causes of visibility impairment in many park areas nationwide. Sulfates are usually the largest single contributor to visibility impairment; however, nitrates and organic compounds also contribute significantly in some regions of the country.

tion of air pollutants. These models are used to estimate source contributions to, and to identify source regions responsible for, observed pollutant loadings.

Joint Monitoring and Research

The Fish and Wildlife Service Air Quality Branch and the NPS Air Resources Division operate under an interagency agreement and are collocated in Lakewood, Colorado. Expertise from both agencies is pooled to address the air quality issues that are the responsibility of the Assistant Secretary of the Interior for Fish and Wildlife and Parks.

- Agricultural Water Resources Decision Support (AWARDS) and
- Evapotranspiration Toolbox (ET Toolbox) system.

The SAMS hydrologic modeling system is being used in WaRSMP to assist water resource managers in developing likely hydrologic scenarios for water supplies. It allows users to test various water resources management strategies, including extreme drought and high-flow scenarios which haven't been encountered in the historical peri-

operations management, and is especially useful during periods of drought and surplus - as demonstrated by the recent "Colorado River Interim Surplus Criteria: Final Environmental Impact Statement"

(http://www.usbr.gov/lc/region/g4000/surplus/SURPLUS_FEIS.HTML).

Current Reclamation projects under WaRSMP include:

- Planning and developing HDB, MMS and RiverWare systems for the Gunnison, San Juan, Rio Grande, Yakima, and Truckee river systems;
- Development of expanded capabilities

ties to allow HDB to function as the Database of Record which will document management decisions and the data used to make them for Reclamation's Upper and Lower Colorado regions as well as other participating offices.

- SAMS integration and testing for the Colorado River Basin;
- Implementing AWARDS systems to improve the efficiency of water management and irrigation scheduling for the Tualatin Project, Upper Columbia project areas, and Lower Colorado area;
- Developing the AWARDS/ET Toolbox system in the Middle Rio Grande and providing 24-hour water use estimates for input, via the Corps of Engineers' Hydrologic Engineering Center Decision Support System or a new HDB, to the Rio Grande RiverWare; and
- Implementing similar AWARDS/ET Toolbox systems with input to local HDBs and RiverWare systems in the Upper Columbia, Lower Colorado, and possibly the Truckee-Carson areas.



BUREAU OF RECLAMATION

The Bureau of Reclamation (Reclamation) activities requiring the collection and use of meteorological data include water supply forecasting, snowpack water equivalent assessment, river system management, reservoir operations, irrigation scheduling, drought status assessment, flood hydrology, and projects related to hydroelectric energy resources. One example of such an ongoing activity is the Watershed and River System Management Program (WaRSMP), which is being developed in partnership with the USGS. Information on WaRSMP is at <http://www.usbr.gov/pmts/rivers/warsmp/index.html>.

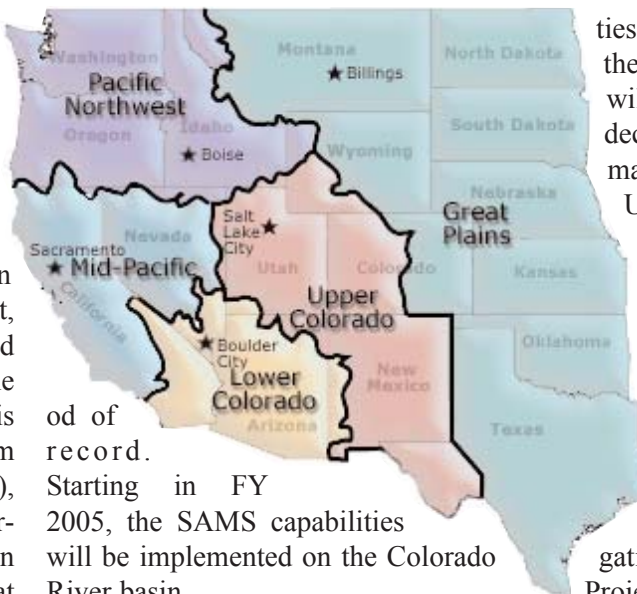
Other key players in this effort include TVA, the Corps of Engineers, NOAA, NASA, NRCS, the University of Colorado and Colorado State University. This program provides a data-centered framework for science-based water resources decision making. Major components are:

- Hydrologic Database (HDB),
- Modular Modeling System (MMS),
- RiverWare river system modeling framework,
- Stochastic Analysis, Modeling and Simulation (SAMS) system,

od of record. Starting in FY 2005, the SAMS capabilities will be implemented on the Colorado River basin.

The RiverWare and HDB data-centered decision support system enables water managers to examine a variety of observed and forecast hydrologic scenarios using hourly, daily, or monthly data within the legal and physical constraints on operations of the river system. This model provides a holistic management tool for watershed and river systems, in order to meet a variety of competing demands for water.

Each new river system requires considerable development work (2-3 years) for RiverWare and HDB implementation. However, such a system can provide for efficient water



- Integration and testing of emerging Land Surface Modeling Products from NASA's Global Land Data Assimilation Systems for snow mapping, surface energy and water budgets and ET analysis and prediction for water operations management.
- Testing and development of weather and climate products from the Global Energy and Water Cycle Experiment (GEWEX) for water supply and demand forecasting.

An additional product of the WaRSMP is the Hydrologic Modeling Inventory (HMI) which provides general technical information and contacts for a wide variety of water resources models presently in use. The HMI is being expanded and can be accessed on the Web at www.usbr.gov/pmts/rivers/hmi.

Instrumentation and Data Acquisition

NEXRAD estimates of precipitation are used for water supply and water delivery decision-making. Water managers can view the distribution of precipitation over watersheds that supply water to storage facilities, and examine the detailed spatial distributions of precipitation over the irrigated areas along with estimates of soil moisture, and evapotranspiration from crops and riparian vegetation.

The Watershed and River Systems Management Program focuses on integrating multi-disciplinary science into decision support systems that enable water managers to make the best deliveries of water to stakeholders.

Currently, Reclamation's HYDROMET system collects data from approximately 400 hydrometeorological data collection platforms (DCPs) which transmit data in real-time through GOES to Reclamation's DRGS in Boise, Idaho. AGRIMET is another network of 60 DCPs dedicated to analysis of crop water use and water conservation in the Pacific Northwest.

Data collected and products created in Boise are electronically transferred to other BLM, Federal and state offices.

Reclamation's primary real-time hydrometeorological information from the NWS, USGS, NASA, and other agencies is displayed on the AWARDS / NEXRAD / ET Toolbox web site: <http://www.usbr.gov/pmts/rivers/awards/index.html>.

Water supply information from cumulative precipitation estimates from radar is also provided in areas where snow fall is an important source of water. Links directly to the USDA Natural Resources Conservation Service and the NOAA/National

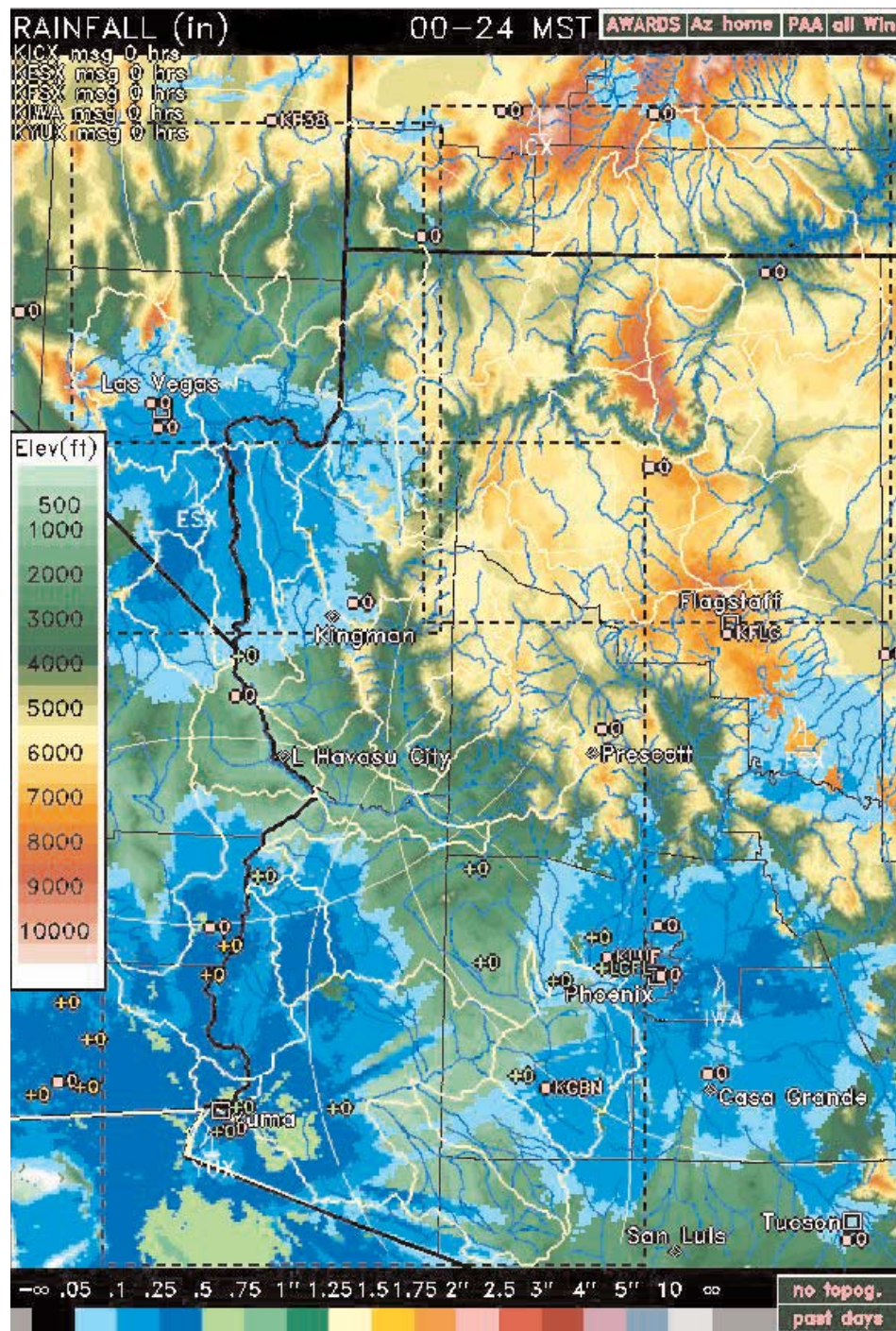


Figure 3-DOI-5. Agricultural Water Resources Decision-Support (AWARDS)/ET Toolbox example for the Lower Colorado River basin. AWARDS merges the precipitation accumulation algorithm (PAA) estimates from five WSR-88D (or NEXRAD) radars into a 2x2km grid.

Center for Environmental Prediction analysis and forecasting web sites are provided to further document the latest information.

Technical Information. Reclamation is a partner with several large western municipal water providers in the study of benefits from the implementation of water conserving landscaping. The study known as the National Xeriscape Demonstration Program includes the development of a numerical evapotranspiration-based model that will use municipal logistical and climatological

data as inputs to develop benefit estimates for municipalities of the West. A report has now been completed and it will be posted on the web shortly.

Some early suggestions from the study point to inefficient irrigation by homeowners caused by inefficient systems and operation, in addition to using high water-consuming landscape plants. More study is needed on development of "smart" irrigation scheduling systems and centralized control by water providers.

During abnormal regional climate conditions, Reclamation meteorologists assist water managers by evaluating environmental information and providing guidance based on the NOAA Climate Prediction Center's (CPC) Weekly Hazards Briefing updates and CPC's seasonal and annual climate forecasts. Special related studies are done upon the request of Reclamation water operations managers, policy team leaders, and cooperating agencies.